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places where the soil is thin. In such places they are too short to be harvested.

A very careful study of the plants has been made in the field and laboratory, but nothing in the way of a fungous or animal parasite that could cause the trouble has been found. From the nature of the disease our attention has been directed mainly to a study of it from a bacterial standpoint. Bacteria have been found in every specimen examined. Nearly 200 cultures have been made in at least a dozen different media and all have yielded two germs, one of which is exceedingly abundant. In nearly 50 cases the disease has been produced in young pot-grown plants by inoculating from direct material. Inoculations of young plants with pure cultures are now under way and it is hoped that some definite results will soon be obtained from this source.*

There is still a possibility that although the disease may be caused by bacteria they are dependent upon certain conditions of the atmosphere for their development, and need not be feared another year. Experiments to settle this question are also under way.

COPPER-SODA AND COPPER-GYPSUM AS REMEDIES FOR GRAPE MILDEW.

BY J. NESSLER.

(Translated from Biedermann's *Centrall-Blatt* for April, 1890, by Gerald McCarthy, N. C. Experiment Station.)

For several years preparations of copper-soda and copper-lime have been employed for mildew of the grape with good success. Neither of these preparations do any injury to the sensitive parts of the vine. The copper-soda mixture neither clogs the openings of the sprayer nor interrupts the spray by foaming; moreover, it sticks to the leaves very well. With this mixture the granular deposit is formed less rapidly the first day, but after that more rapidly than is the case with the copper-lime mixture. Sulphate of copper is decomposed equally well by soda and by lime. The granular deposit takes place sooner or later, according to the method of preparing the mixtures. Once formed, the pulverulent mass returns to its former state very quickly after being stirred, and on this account it is liable to clog the opening of the sprayer. More particularly is this the case when the lime used is not very finely divided or the copper solution is not sufficiently diluted. One should therefore use in mixing only a perfectly homogeneous lumpless lime-cream and copper solution so dilute that little or no additional water

* Since writing this the disease has been produced in fifty or more cases by inoculating with the more abundant organism. Five days after inoculating, the characteristic discolorations appeared, and cultures made from these have yielded the typical organism in a nearly pure condition.

need be added before using. Neither mixture should be kept more than one day before being used. The lime gradually precipitates the copper in needle-shaped and granular particles, which very quickly clog the spraying-nozzle. The copper-soda solution after a short time becomes wholly unserviceable on account of the granular deposit. The more or less rapid formation of the deposit depends on the strength of the solution in soda. If, for example, one uses $4\frac{1}{2}$ pounds sulphate of copper and $5\frac{3}{4}$ pounds of soda, the deposit takes place in eight or ten hours, whereas by using only 5 pounds of soda the solution remains serviceable for twenty-four hours or longer.

In using the copper-lime and copper-soda preparations one should observe the following rules:

- (1) The lime must be reduced to a homogeneous lumpless cream.
- (2) Both the lime-cream and soda solution must be added only to a very dilute solution of copper sulphate. Indeed this should be so dilute that no subsequent addition of water will be necessary.
- (3) Although a larger amount of lime than is necessary may be added without injury to the foliage of the plants, yet according to the quantity of the lime used will be the rapidity with which the pulverulent precipitate is formed. Any surplus of soda will injure the foliage.
- (4) The mixture must not be stored, but used immediately after it is prepared.

If one has water handy to the field it may be more convenient and expeditious to prepare at the house strong simple solutions of copper sulphate and soda, and dilute them afterwards in the field. One may, for example, wet 2 pounds 3 ounces copper sulphate with $1\frac{1}{4}$ gallon of water and 2 pounds 9 ounces soda with the same quantity of water, and for this purpose hot water is the best. Twenty-six ounces of burnt lime or $5\frac{1}{2}$ pounds of air-slaked lime will produce $1\frac{1}{4}$ gallon of lime-cream. For the production of the final mixtures dilute $2\frac{1}{2}$ gallons of the copper solution to 26 gallons and add $2\frac{1}{2}$ gallons of the soda solution or the same quantity of the lime-cream. Weak mixtures act about as well as strong ones, and instead of $4\frac{1}{4}$ pounds copper sulphate, one may use only 2 pounds 3 ounces. In place of 5 pounds of soda, 2 pounds 9 ounces may be used. But where the weaker mixtures are employed, it is recommended to spray somewhat more copiously.

The author has also experimented with a dry powder composed of 10 parts copper sulphate, 10 parts burnt lime, and 100 parts calcined gypsum.

Spraying with liquids is preferable to dusting with powders, because in liquid form the copper is more divided and sticks longer to the leaves; the effect being therefore more permanent. On the other hand the powder is very convenient in cases where an effective spraying apparatus is wanting and in situations where water is difficult to procure. Moreover the powder can be applied by women; the liquids can not.